



## SECTION SF 30 BLOCK 14 CONTINUATION PAGE

This amendment is issued to incorporate the following into the solicitation:

1. Incorporated herein is Section 16375, Electrical Distribution System, Underground.
2. The following specifications are revised:
  - a. Revisions to Section 00800, Miscellaneous Drawings by notation in the Special Clauses.
  - b. Revisions to Section 13854M1, Paragraph 10.0, to require that installation of fire alarms be done by licensed electricians.
  - c. Revisions to Table of Contents.
3. Date and Time for receipt of proposals remain 28 February, 2002, 2:00 P.M. Pacific Time.
4. NOTICE TO OFFERORS: Offerors must acknowledge receipt of this amendment by number and date on the invitation for bid, or by telegram. Please also mark the outside of your envelope containing your bid to show amendment received.

Encl:

Section 00800 (revised)  
Table of Contents  
Section 13854M1 (revised)  
Section 16375 (new)

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## SPECIAL CLAUSES

### SC-1. COMMENCEMENT, PROSECUTION, AND COMPLETION OF WORK (APR 1984) (FAR 52.211-10).

The Contractor shall be required to (a) commence work under this Contract within 10 calendar days after the date the Contractor receives the notice to proceed, (b) prosecute the work diligently, and (c) complete the entire work ready for use not later than 365 calendar days after date of receipt by Contractor of notice to proceed. The time stated for completion shall include final cleanup of the premises.

#### SC-1.1 OPTION FOR INCREASED QUANTITY

a. The Government may increase the quantity of work awarded by exercising one or more of the Optional Bid Item(s) 0006 through 0009 at any time, or not at all, but no later than 180 calendar days after receipt by Contractor of notice to proceed. Notice to proceed on work Item(s) added by exercise of the option(s) will be given upon execution of consent of surety.

b. The parties hereto further agree that any option herein shall be considered to have been exercised at the time the Government deposits written notification to the Contractor in the mails.

c. The time allowed for completion of any optional items awarded under this contract will be the same as that for the base item(s), and will be measured from the date of receipt of the notice to proceed for the base item(s).

### SC-2. LIQUIDATED DAMAGES - CONSTRUCTION (APR 1984) (FAR 52.211-12)

(a) If the Contractor fails to complete the work within the time specified in the Contract, or any extension, the Contractor shall pay to the Government as liquidated damages, the sum of \$1,032.00 for each day of delay.

(b) If the Government terminates the Contractor's right to proceed, the resulting damage will consist of liquidated damages until such reasonable time as may be required for final completion of the work together with any increased costs occasioned the Government in completing the work.

(c) If the Government does not terminate the Contractor's right to proceed, the resulting damage will consist of liquidated damages until the work is completed or accepted.

SC-3 AND SC-4 DELETED.

### SC-5. INSURANCE - WORK ON A GOVERNMENT INSTALLATION (SEP 1989) (FAR 52.228-5)

(a) The Contractor shall, at its own expense, provide and maintain during the entire performance period of this Contract at least the kinds and minimum amounts of insurance required in the Insurance Liability Schedule or elsewhere in the Contract.

(b) Before commencing work under this Contract, the Contractor shall certify to the Contracting Officer in writing that the required insurance has been obtained. The policies evidencing required insurance shall contain an endorsement to the effect that any cancellation or any material change adversely affecting the Government's interest shall not be effective:

(1) for such period as the laws of the State in which this Contract is to be performed prescribe;  
or

(2) until 30 days after the insurer or the Contractor gives written notice to the Contracting Officer, whichever period is longer.

(c) The Contractor shall insert the substance of this clause, including this paragraph (c), in subcontracts under this Contract that require work on a Government installation and shall require subcontractors to provide and maintain the insurance required in the Schedule or elsewhere in the Contract. The Contractor shall maintain a copy of all subcontractors' proofs of required insurance, and shall make copies available to the Contracting Officer upon request.

(d) Insurance Liability Schedule (FAR 28.307-2)

(1) Workers' compensation and employer's liability. Contractors are required to comply with applicable Federal and State workers' compensation and occupational disease statutes. If occupational diseases are not compensable under those statutes, they shall be covered under the employer's liability section of the insurance policy, except when Contract operations are so commingled with a Contractor's commercial operation that it would not be practical to require this coverage. Employer's liability coverage of at least \$100,000 shall be required, except in states with exclusive or monopolistic funds that do not permit workers' compensation to be written by private carriers.

(2) General Liability.

(a) The Contracting Officer shall require bodily injury liability insurance coverage written on the comprehensive form of policy of at least \$500,000 per occurrence.

(b) Property damage liability insurance shall be required only in special circumstances as determined by the agency.

(3) Automobile liability. The Contracting Officer shall require automobile liability insurance written on the comprehensive form of policy. The policy shall provide for bodily injury and property damage liability covering the operation of all automobiles used in connection with performing the Contract. Policies covering automobiles operated in the United States shall provide coverage of at least \$200,000 per person and \$500,000 per occurrence for bodily injury and \$20,000 per occurrence for property damage. The amount of liability coverage on other policies shall be commensurate with any legal requirements of the locality and sufficient to meet normal and customary claims.

(4) Aircraft public and passenger liability. When aircraft are used in connection with performing the Contract, the Contracting Officer shall require aircraft public and passenger liability insurance. Coverage shall be at least \$200,000 per person and \$500,000 per occurrence for bodily injury, other than passenger liability, and \$200,000 per occurrence for property damage. Coverage for passenger liability

bodily injury shall be at least \$200,000 multiplied by the number of seats or passengers, whichever is greater.

(5) Environmental Liability If this contract includes the transport, treatment, storage, or disposal of hazardous material waste the following coverage is required.

The Contractor shall ensure the transporter and disposal facility have liability insurance in effect for claims arising out of the death or bodily injury and property damage from hazardous material/waste transport, treatment, storage and disposal, including vehicle liability and legal defense costs in the amount of \$1,000,000.00 as evidenced by a certificate of insurance for General, Automobile, and Environmental Liability Coverage. Proof of this insurance shall be provided to the Contracting Officer.

SC-6 DELETED.

SC-7. PERFORMANCE OF WORK BY THE CONTRACTOR (APR 1984) (FAR 52.236-1): The Contractor shall perform on the site, and with its own organization, work equivalent to at least fifteen percent (15%) of the total amount of work to be performed under the Contract. The percentage may be reduced by a supplemental agreement to this Contract if, during performing the work, the Contractor requests a reduction and the Contracting Officer determines that the reduction would be to the advantage of the Government.

SC-8. PHYSICAL DATA (APR 1984) (FAR 52.236-4): Data and information furnished or referred to below is for the Contractor's information. The Government will not be responsible for any interpretation of or conclusion drawn from the data or information by the Contractor.

(a) Physical Conditions: The indications of physical conditions on the drawings and in the specifications are the result of site investigations by test holes shown on the drawings.

(b) Weather Conditions: Each bidder shall be satisfied before submitting his bid as to the hazards likely to arise from weather conditions. Complete weather records and reports may be obtained from any National Weather Service Office.

(c) Transportation Facilities: Each bidder, before submitting his bid, shall make an investigation of the conditions of existing public and private roads and of clearances, restrictions, bridge load limits, and other limitations affecting transportation and ingress and egress at the jobsite. The unavailability of transportation facilities or limitations thereon shall not become a basis for claims for damages or extension of time for completion of the work.

(d) Right-of-Way: The right-of-way for the work covered by these specifications will be furnished by the Government, except that the Contractor shall provide right-of-way for ingress and egress across private property where necessary to gain access to the jobsite. The Contractor may use such portions of the land within the right-of-way not otherwise occupied as may be designated by the Contracting Officer. The Contractor shall, without expense to the Government, and at any time during the progress of the work when space is needed within the right-of-way for any other purposes, promptly vacate and clean up any part of the grounds that have been allotted to, or have been in use by, him when directed to do so by the Contracting Officer. The Contractor shall keep the buildings and grounds in use by him at the site of the work in an orderly and sanitary condition. Should the Contractor require additional working space or lands

for material yards, job offices, or other purposes, he shall obtain such additional lands or easements at his expense.

SC-9 DELETED.

SC-10. LAYOUT OF WORK (APR 1984) (FAR 52.236-17): The Contractor shall lay out its work from Government-established base lines and bench marks indicated on the drawings, and shall be responsible for all measurements in connection with the layout. The Contractor shall furnish, at its own expense, all stakes, templates, platforms, equipment, tools, materials, and labor required to lay out any part of the work. The Contractor shall be responsible for executing the work to the lines and grades that may be established or indicated by the Contracting Officer. The Contractor shall also be responsible for maintaining and preserving all stakes and other marks established by the Contracting Officer until authorized to remove them. If such marks are destroyed by the Contractor or through its negligence before their removal is authorized, the Contracting Officer may replace them and deduct the expense of the replacement from any amounts due, or to become due, to the Contractor.

SC-11 DELETED.

SC-12. AIRFIELD SAFETY PRECAUTIONS (DEC 1991) (DOD FAR SUPP 252.236-7005)

(a) Definitions: As used in this clause --

(1) "Landing Areas" means:

(i) the primary surfaces which are comprised of the surface of the runways, the runway shoulders, and the lateral safety zones (the length of each primary surface is the same as the runway length; the width of each primary surface is 610 meters (2,000 feet), 305 meters (1,000 feet) on each side of the runway centerline; (see footnote at end of clause)).

(ii) the "clear zone" beyond the ends of each runway, i.e., the extension of the "primary surface" for a distance of 305 meters (1,000 feet) beyond each end of each runway;

(iii) all taxiways plus the lateral clearance zones along each side for the length of the taxiways (the outer edge of each lateral clearance zone is laterally 76 meters (250 feet) from the far or opposite edge of the taxiway, i.e., a 23 meters (75-foot)-wide taxiway would have a combined width of taxiway and lateral clearance zones of 130 meters (425 feet); and

(iv) all aircraft parking aprons plus the area 38 meters (125 feet) in width extending beyond each edge all around the aprons.

(2) "Safety precaution areas" means those portions of approach-departure clearance zones and transitional zones where placement of objects incident to Contract performance might result in vertical projections at or above the approach-departure clearance surface or the transitional surface.

(i) The "approach-departure clearance surface" is an extension of the primary surface and the clear zone at each end of each runway, for a distance of 15,240 meters (50,000 feet), first along an inclined (glide angle) and then along a horizontal plane, both flaring symmetrically about the runway centerline extended.

(a) The inclined plane (glide angle) begins in the clear zone 61 meters (200 feet) past the end of the runway (and primary surface) at the same elevation as the end of the runway, and continues upward at a slope of 50:1 (.3048 meter (one foot) vertically for each 15.24 meters (50 feet) horizontally) to an elevation of 152 meters (500 feet) above the established airfield elevation; at that point the plane becomes horizontal, continuing at that same uniform elevation to a point 15,240 meters (50,000 feet) longitudinally from the beginning of the inclined plane (glide angle) and ending there.

(b) The width of the surface at the beginning of the inclined plane (glide angle) is the same as the width of the clear zone; thence it flares uniformly, reaching the maximum width of 4,877 meters (16,000 feet) at the end.

(ii) The "approach-departure clearance zone" is the ground area under the approach-departure clearance surface.

(iii) The "transitional surface" is a sideways extension of all primary surfaces, clear zones, and approach-departure clearance surfaces along inclined planes.

(a) The inclined plane in each case begins at the edge of the surface.

(b) The slope of the inclined plane is 7:1 (.3048 meter (one foot) vertically for each 2.13 meters (7 feet) horizontally), and it continues to the point of intersection with

(1) Inner horizontal surface (which is the horizontal plane 46 meters (150 feet) above the established airfield elevation) or

(2) Outer horizontal surface (which is the horizontal plane 152 meters (500 feet) above the established airfield elevation), whichever is applicable.

(iv) The "transitional zone" is the ground area under the transitional surface. (It adjoins the primary surface, clear zone and approach-departure clearance zone.)

(b) General

(1) The Contractor shall comply with the requirements of this clause while

(i) Operating all ground equipment (mobile or station art);

(ii) Placing all materials; and

(iii) Performing all work, upon and around all airfields.

(a) The requirements of this clause are in addition to any other safety requirements of this contract.

(c) The Contractor shall--

(1) Report to the Contracting Officer before initiating any work;

(2) Notify the Contracting Officer of proposed changes to locations and operations;

(3) Not permit either its equipment or personnel to use any runway for purposes other than aircraft operation without permission of the Contracting Officer, unless the runway is--

(i) Closed by order of the Contracting Officer, and

(ii) Marked as provided in paragraph (d)(2) of this clause;

(4) Keep all paved surfaces such as runways, taxiways, and hardstands, clean at all times and, specifically, free from small stones which might damage aircraft propellers or jet aircraft;

(5) Operate mobile equipment according to the safety provisions of this clause, while actually performing work on the airfield. At all other times, the Contractor shall remove all mobile equipment to locations--

(i) Approved by the Contracting Officer,

(ii) At a distance of at least 229 meters (750 feet) from the runway centerline, plus any additional distance; and

(iii) Necessary to ensure compliance with the other provisions of this clause; and

(6) Not open a trench unless material is on hand and ready for placing in the trench. As soon as practicable after material has been placed and work approved, the Contractor shall backfill and compact trenches as required by the contract. Meanwhile, all hazardous conditions shall be marked and lighted in accordance with the other provisions of this clause.

(e) Landing Areas

The Contractor shall--

(1) Place nothing upon the landing areas without the authorization of the Contracting Officer.

(2) Outline those landing areas hazardous to aircraft, using (unless otherwise authorized by the Contracting Officer) red flags by day, and electric, battery-operated low-intensity red flasher lights by night;

(3) Obtain, at an airfield where flying is controlled, additional permission from the control tower operator every time before entering any landing area, unless the landing area is marked as hazardous in accordance with paragraph (d)(2) of this clause;

(4) Identify all vehicles it operates in landing areas by means of a flag on a staff attached to, and flying above, the vehicle. The flag shall be .9144 meters (3 feet) square, and consist of a checkered pattern of international orange and white squares of .3048 meter (1 foot) on each side (except that the flag may vary up to 10 percent from each of these dimensions);

(5) Mark all other equipment and materials in the landing areas, using the same marking devices as in paragraph (d)(2) of this clause; and

(6) Perform work so as to leave that portion of the landing area which is available to aircraft free from hazards, holes, piles of material, and projecting shoulders that might damage an airplane tire.

(e) Safety Precaution Areas

The Contractor shall--

(1) Place nothing upon the safety precaution areas without authorization of the Contracting Officer;

(2) Mark all equipment and materials in safety precaution areas, using (unless otherwise authorized by the Contracting Officer) red flags by day, and electric, battery-operated, low-intensity red flasher lights by night; and

(3) Provide all objects placed in safety precaution areas with a red light or red lantern at night, if the objects project above the approach-departure clearance surface or above the transitional surface.

SC-13 DELETED.

SC-14. EQUIPMENT OWNERSHIP AND OPERATING EXPENSE SCHEDULE (MAR 1995)-  
(EFARS 52.231-5000)

(a) This clause does not apply to terminations. See 52.249-5000, Basis for Settlement of Proposals and FAR Part 49.

(b) Allowable cost for construction and marine plant and equipment in sound workable condition owned or controlled and furnished by a contractor or subcontractor at any tier shall be based on actual cost data for each piece of equipment or groups of similar serial and series for which the Government can determine both ownership and operating costs from the contractor's accounting records. When both ownership and operating costs cannot be determined for any piece of equipment or groups of similar serial or series equipment from the contractor's accounting records, costs for that equipment shall be based upon the applicable provisions of EP 1110-1-8, Construction Equipment Ownership and Operating Expense Schedule, Region VIII. Working conditions shall be considered to be average for determining equipment rates using the schedule unless specified otherwise by the contracting officer. For equipment not included in the schedule, rates for comparable pieces of equipment may be used or a rate may be developed using the formula provided in the schedule. For forward pricing, the schedule in effect at the time of negotiations shall apply. For retroactive pricing, the schedule in effect at the time the work was performed shall apply.

(c) Equipment rental costs are allowable, subject to the provisions of FAR 31.105(d)(ii) and FAR 31.205-36. Rates for equipment rented from an organization under common control, lease-purchase arrangements, and sale-leaseback arrangements, will be determined using the schedule, except that actual rates will be used for equipment leased from an organization under common control that has an established practice of leasing the same or similar equipment to unaffiliated lessees.

(d) When actual equipment costs are proposed and the total amount of the pricing action exceeds the small purchase threshold, the contracting officer shall request the contractor to submit either certified cost or pricing data, or partial/limited data, as appropriate. The data shall be submitted on Standard Form 1411, Contract Pricing Proposal Cover Sheet.

(e) Copies of EP1110-1-8 "Construction Equipment Ownership and Operating Expense Schedule" Volumes 1 through 12 are available in Portable Document Format (PDF) and can be viewed or downloaded at <http://www.usace.army.mil/inet/usace-docs/eng-pamphlets/cecw.htm>. A CD-ROM containing (Volumes 1-12) is available through either the Superintendent of Documents or Government bookstores. For additional information telephone 202-512-2250, or access on the Internet at [http://www.access.gpo.gov/su\\_docs](http://www.access.gpo.gov/su_docs).

SC-15. PAYMENT FOR MATERIALS DELIVERED OFF-SITE (MAR 1995)-(EFARS 52.232-5000)

(a) Pursuant to FAR clause 52.232-5, Payments Under Fixed Priced Construction Contracts, materials delivered to the contractor at locations other than the site of the work may be taken into consideration in making payments if included in payment estimates and if all the conditions of the General Provisions are fulfilled. Payment for items delivered to locations other than the work site will be limited to: (1) materials required by the technical provisions; or (2) materials that have been fabricated to the point where they are identifiable to an item of work required under this contract.

(b) Such payment will be made only after receipt of paid or receipted invoices or invoices with canceled check showing title to the items in the prime contractor and including the value of material and labor incorporated into the item. In addition to petroleum products, payment for materials delivered off-site is limited to the following items: Any other construction material stored offsite may be considered in determining the amount of a progress payment.

SC-16 AND SC-17 DELETED.

SC-18. CONTRACT DRAWINGS, MAPS, AND SPECIFICATIONS (OCT 1996) (52.0236-4001 EBS)

(a) The Government--

(1) Will provide the Contractor, without charge, one set of contract drawings and one set of specifications in electronic format on a compact disk. The Government will not give the Contractor any hard copy paper drawings or specifications for any contract resulting from this solicitation.

(b) The Contractor shall--

- (1) check all drawings furnished immediately upon receipt;
- (2) Compare all drawings and verify the figures before laying out the work;
- (3) Promptly notify the Contracting Officer of any discrepancies;

and

(4) Be responsible for any errors which might have been avoided by complying with this paragraph (b).

(c) Large scale drawings shall, in general, govern small scale drawings. Figures marked on drawings shall, in general, be followed in preference to scale measurements.

(d) Omissions from the drawings or specifications or the misdescription of details of work which are manifestly necessary to carry out the intent of the drawings and specifications, or which are customarily performed, shall not relieve the Contractor from performing such omitted or misdescribed details of the work, but shall be performed as if fully and correctly set forth and described in the drawings and specifications.

(e) The work shall conform to the specifications and the contract drawings identified in the index of drawings attached at the end of the Special Clauses.

SC-19 THROUGH SC-21 DELETED.

SC-22. EPA ENERGY STAR: The Government requires that certain equipment be Energy Star compliant. Initially, the sole Energy Star requirement shall be the self certification by the bidder that the specified equipment is Energy Star compliant. Within 3 months of the availability of an EPA sanctioned test for Energy Star compliance, the Contractor shall submit all equipment upgrades and additions for testing and provide proof of compliance to the Government upon completion of testing. Testing shall be at the Contractor's expense.

SC-23. RECOVERED MATERIALS: The Corps of Engineers encourages all bidders to utilize recovered materials to the maximum extent practicable. The attached APPENDIX R contains procurement guidelines for products containing recovered materials.

## APPENDIX R

### PART 247 - COMPREHENSIVE PROCUREMENT GUIDELINE FOR PRODUCTS CONTAINING RECOVERED MATERIALS

40 CFR Ch. 1 (9-1-99 Edition)

#### Subpart B-Item Designations

§ 247.10 Paper and paper products.

Paper and paper products, excluding building and construction paper grades.

§ 247.11 Vehicular products.

- (a) Lubricating oils containing re-refined oil, including engine lubricating oils, hydraulic fluids, and gear oils, excluding marine and aviation oils.
- (b) Tires, excluding airplane tire
- (e) Reclaimed engine coolants, excluding coolants used in non-vehicular applications.

247.12 Construction products.

- (a) Building insulation product including the following items:
  - (1) Loose-fill insulation, including but not limited to cellulose fiber, mineral fibers (fiberglass and rock vermiculite, and perlite);
  - (2) Blanket and batt insulation, including but not limited to mineral fibers (fiberglass and rock wool).
  - (3) Board (sheathing, roof decking wall panel) insulation, including but not limited to structural fiberboard and laminated paperboard products perlite composite board, polyurethane, polyisocyanurate, polystyrene, phenolics, and composites; and
  - (4) Spray-in-place insulation, including but not limited to foam-in-place polyurethane and polyisocyanurate and spray-on cellulose.
- (b) Structural fiberboard and laminated paperboard products for applications other than building insulation, including building board, sheathing shingle backer, sound deadening board, roof insulating board, insulating wallboard, acoustical and non-acoustical ceiling tile, acoustical and non-acoustical lay-in panels, floor underlayments, and roof overlay (cover board).
- (c) Cement and concrete, including concrete products such as pipe and block, containing coal fly as ground granulated blast furnace (GGBF) slag.
- (d) Carpet made of polyester fiber use in low- and medium-wear applications.
- (e) Floor tiles and patio block containing recovered rubber or plastic.
- (f) Shower and restroom dividers/partitions containing recovered plastic or steel.
- (g) (1) Consolidated latex paint used for covering graffiti; and
- (2) Reprocessed latex paint used for interior and exterior architectural applications such as wallboard, ceilings, and trim; gutter boards; and concrete, stucco, masonry, wood and metal surfaces.

§247.13 Transportation products.

- (a) Traffic barricades and traffic cones used in controlling or restricting vehicular traffic.

- (b) Parking stops made from concrete or containing recovered plastic or rubber.
- (c) Channelizers containing recovered plastic or rubber.
- (d) Delineators containing recovered plastic, rubber, or steel.
- (e) Flexible delineators containing recovered plastic.

§ 247.14 Park and recreation products

- (a) Playground surfaces and running tracks containing recovered rubber or plastic.
- (b) Plastic fencing containing recovered plastic for use in controlling snow or sand drifting and as a warning/safety barrier in construction or other applications.

247.15 Landscaping products.

- (a) Hydraulic mulch products containing recovered paper or recovered wood used for hydroseeding and as an over-spray for straw mulch in landscaping, erosion control, and soil reclamation.
- (b) Compost made from yard trimmings, leaves, and/or grass clippings for use in landscaping, seeding of grass or other plants on roadsides and embankments, as a nutritious mulch under trees and shrubs, and in erosion control and soil reclamation.
- (c) Garden and soaker hoses containing recovered plastic or rubber.
- (d) Lawn and garden edging containing recovered plastic or rubber.

§ 247.16 Non-paper office product.

- (a) Office recycling containers and office waste receptacles.
- (b) Plastic desktop accessories.
- (c) Toner cartridges.
- (d) Binders.
- (e) Plastic trash bags.
- (f) Printer ribbons.
- (g) Plastic envelopes.

§ 247.17 Miscellaneous products.

Pallets containing recovered wood, plastic, or paperboard.

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12	T1M-4	Control Diagrams And Floor Plan – Bldg 1166		14 DEC 2001
13	T1M-5	Hydronics System Control Diagrams – Bldg 1166		14 DEC 2001
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2	T2A-2	Addition Floor Plan – Bldg 1167		14 DEC 2001
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9	T2M-1	Mechanical Legend And Schedules – Bldg 1167		14 DEC 2001
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19	T2E-2	Electrical Demolition Plan – Bldg 1167		14 DEC 2001
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**REVISIONS TO DRAWINGS BY NOTATION**

Drawing, Sheet T-1: On the Area Map, relocate arrow to indicate haul route is to use North, or Main Gate.

Drawing Sheet C-3: Add new note to read: “Provide a 1/2" conduit from the foam diversion valve shown on Sheet C3 to the foam controllers shown on Sheet T1E-5 for the actuation of the valve. Provide connections per manufacturers recommendations.” In Detail 1, Plan, change 15” PVC pipe to 15” DI pipe. In Detail 1, Section, change 18” butterfly valve to 15” butterfly valve.

Drawing Sheet C-5: Relocate FOD fence and limits of construction so that they begin at the farthest point from the face of the building as shown, and then run in a straight line parallel to the front of the building, for the full width of the building. Change the 29’ dimension from the face of the new building extension to the FOD fence to 75’. Add Note 3, to read, “Provide a 1/2" conduit from the foam diversion valves shown on Sheet C3 to the existing fire alarm panels shown on Sheets E-2 and E-3 for the actuation of the valve. Provide connections per manufacturers recommendations.”

Drawing, Sheet F-2: To the note, “A two way Butterfly valve with.....closed position,” add “Butterfly valve shall be rubber-seated model. Materials, manufacture and installation shall be as prescribed in AWWA Standard C504. The actuator motor is 120 volt and the controls are 24 VDC.”

Drawing, Sheet F-3: To the note, “A two way Butterfly valve with.....closed position,” add “Butterfly valve shall be rubber-seated model. Materials, manufacture and installation shall be as prescribed in AWWA Standard C504. The actuator motor is 120 volt and the controls are 24 VDC.”

Drawing Sheet F-4: Delete callout, “Butterfly valve interlocked with fire panel...” In Note 4, change “155° F” to “175° F.” Add Note 7, to read, “The existing electrical heat detector system shall be extended

into the new addition with the area covered by the detector system corresponding with the roof system above defined by draft curtains.”

Drawing Sheet F-5: Delete callout, “Butterfly valve interlocked with fire panel...” Add Note 7, to read, “The existing electrical heat detector system shall be extended into the new addition with the area covered by the detector system corresponding with the roof system above defined by draft curtains.”

Drawing, Sheet E-2: Change all references to “Plate E-5” to “Plate T1E-5.” Revise first note after Note 11 to read, “... T1E-1, T1E-2, T1E-3, T1E-4 and T1E-5.” Delete the new UV/IR detector located north of the new strobe horn, and relocate the UV/IR detector located south of the new strobe horn closer to the new strobe horn (to the north) for even spacing between detectors (applies to both sides of the hangar). Add Construction Note 12, to read, “Provide a 1/2" conduit from the foam diversion valves shown on Sheet C3 to the existing fire alarm panels shown on Sheets E-2 and E-3 for the actuation of the valve. Provide connections per manufacturers recommendations.”

Drawing, Sheet E-3: Add Construction Note 11, to read, “Provide a 1/2" conduit from the foam diversion valves shown on Sheet C3 to the existing fire alarm panels shown on Sheets E-2 and E-3 for the actuation of the valve. Provide connections per manufacturers recommendations.”

Drawing, Sheet T1A-3: In Elevation E2, Revise the signage note to read, "Remove and re-install existing signage, consisting of approximately thirty 12-inch high metal letters."

Drawing, Sheet TIM-5: In the Existing Hydronic and Steam Control System Schedule, Additional Parameters Column, replace all references to "EXISTING" with "NEW." Revise General Note to read, “Work on this sheet to consist of new DDC control equipment installed within the existing temperature control panel cabinets. Contractor to demo the contents of the existing temperature control panels to make room for the new DDC control equipment. All existing monitoring devices and wiring and conduit from the cabinet to the devices are to be replaced with new. **Conduits are to be replaced with new where existing conduits are unusable.** Contractor shall warrant all components of the finished DDC control system per the contract specifications. Contractor shall replace items as necessary to ensure a fully operational system.”

Drawing, Sheet TIM-7: In the Existing AHU-1 Control System Equipment Schedule (AHU-2 Similar), Comments column, replace all references to "EXISTING" with "NEW." Revise General Note to read, “Work on this sheet to consist of new DDC control equipment installed within the existing temperature control panel cabinets. Contractor to demo the contents of the existing temperature control panels to make room for the new DDC control equipment. All existing monitoring devices and wiring and conduit from the cabinet to the devices are to be replaced with new. **Conduits are to be replaced with new where existing conduits are unusable.** Contractor shall warrant all components of the finished DDC control system per the contract specifications. Contractor shall replace items as necessary to ensure a fully operational system.”

Drawing, Sheet TIM-8: In the Existing AHU-3 Control System Equipment Schedule (AHU-4 Similar), Comments column, replace all references to "EXISTING" with "NEW." Revise General Note to read, “Work on this sheet to consist of new DDC control equipment installed within the existing temperature control panel cabinets. Contractor to demo the contents of the existing temperature control panels to make room for the new DDC control equipment. All existing monitoring devices and wiring and

conduit from the cabinet to the devices are to be replaced with new. **Conduits are to be replaced with new where existing conduits are unusable.** Contractor shall warrant all components of the finished DDC control system per the contract specifications. Contractor shall replace items as necessary to ensure a fully operational system.”

Drawing, Sheet T1M-9: In the Existing AHU-4 Control System Equipment Schedule, Comments column, replace all references to "EXISTING" with "NEW " Revise General Note to read, “Work on this sheet to consist of new DDC control equipment installed within the existing temperature control panel cabinets. Contractor to demo the contents of the existing temperature control panels to make room for the new DDC control equipment. All existing monitoring devices and wiring and conduit from the cabinet to the devices are to be replaced with new. **Conduits are to be replaced with new where existing conduits are unusable.** Contractor shall warrant all components of the finished DDC control system per the contract specifications. Contractor shall replace items as necessary to ensure a fully operational system.”

Drawing Sheet T1E-5: Add new note to read: “Provide a 1/2" conduit from the foam diversion valve shown on Sheet C3 to the foam controllers shown on Sheet T1E-5 for the actuation of the valve. Provide connections per manufacturers recommendations.”

Drawing, Sheet T2A-3: In Elevation E2, Revise the signage note to read, "Remove and re-install existing signage, consisting of approximately thirty 12-inch high metal letters."

Drawing, Sheet T2M-5: In the Existing Hydronic and Steam Control System Schedule, Additional Parameters Column, replace all references to "EXISTING" with "NEW." Revise General Note to read, “Work on this sheet to consist of new DDC control equipment installed within the existing temperature control panel cabinets. Contractor to demo the contents of the existing temperature control panels to make room for the new DDC control equipment. All existing monitoring devices and wiring and conduit from the cabinet to the devices are to be replaced with new. **Conduits are to be replaced with new where existing conduits are unusable.** Contractor shall warrant all components of the finished DDC control system per the contract specifications. Contractor shall replace items as necessary to ensure a fully operational system.”

Drawing, Sheet T2M-7: In the Existing AHU-1 Control System Equipment Schedule (AHU-2 Similar), Comments column, Replace all reference to "EXISTING" with "NEW." Revise General Note to read, “Work on this sheet to consist of new DDC control equipment installed within the existing temperature control panel cabinets. Contractor to demo the contents of the existing temperature control panels to make room for the new DDC control equipment. All existing monitoring devices and wiring and conduit from the cabinet to the devices are to be replaced with new. **Conduits are to be replaced with new where existing conduits are unusable.** Contractor shall warrant all components of the finished DDC control system per the contract specifications. Contractor shall replace items as necessary to ensure a fully operational system.”

Drawing, Sheet T2M-8: In the Existing AHU-3 Control System Equipment Schedule (AHU-4 Similar), Comments column, Replace all reference to "EXISTING" with "NEW." Revise General Note to read, “Work on this sheet to consist of new DDC control equipment installed within the existing temperature control panel cabinets. Contractor to demo the contents of the existing temperature control panels to make room for the new DDC control equipment. All existing monitoring devices and wiring and conduit from the cabinet to the devices are to be replaced with new. **Conduits are to be replaced with**

new where existing conduits are unusable . Contractor shall warrant all components of the finished DDC control system per the contract specifications. Contractor shall replace items as necessary to ensure a fully operational system.”

Drawing, Sheet T2M-9: In the Existing AHU-4 Control System Equipment Schedule, Comments column, replace all reference to "EXISTING" with "NEW." Revise General Note to read, “Work on this sheet to consist of new DDC control equipment installed within the existing temperature control panel cabinets. Contractor to demo the contents of the existing temperature control panels to make room for the new DDC control equipment. All existing monitoring devices and wiring and conduit from the cabinet to the devices are to be replaced with new. **Conduits are to be replaced with new where existing conduits are unusable . Contractor shall warrant all components of the finished DDC control system per the contract specifications. Contractor shall replace items as necessary to ensure a fully operational system.”**

STANDARD DETAILS BOUND IN THE SPECIFICATIONS

DRAWING NUMBER	SHEET NUMBER	TITLE	DATE
<u>SECTION 01501 - CONSTRUCTION FACILITIES AND TEMPORARY CONTROLS</u>			
	1 & 2	U.S. Air Force Project Construction Sign	84JUN20
	1	Hard Hat Sign	10SEP90

END OF SECTION

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**FY02 C-17 EXTEND NOSE DOCKS (BUILDINGS 1166 AND 1167)  
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FINAL SUBMITTAL**

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SECTION 13854M1

FIRE ALARM SPECIFICATIONS

PART 1 GENERAL

1. APPLICABLE PUBLICATIONS: The publications listed below form a part of this specification.

1.1 The installation shall conform to the current edition and applicable sections of the following NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) STANDARDS:

70	1999	National Electric Code.
72	1999	National Fire Alarm Code.
90A	1999	Installation of Air Conditioning and Ventilating Systems.
90B	1999	Standard for the Installation of Warm Air Heating and Air Conditioning Systems.
101	2000	Life Safety Code.
170	1999	Fire Safety Symbols.

1.2 The following UNDERWRITERS LABORATORIES, Inc. (UL) PUBLICATIONS APPLY:

UL 4	Fire Protection Equipment Directory
UL 6	Rigid Metal Conduit
UL 38	Manually Actuated Signaling Boxes for use with Fire Protective Signaling Systems.
UL 217	Single and Multiple Station Smoke Detectors.
UL 228	Door-Closer-Holders with or without Integral Smoke Detectors.
UL 268	Smoke Detectors for Fire Protective Signaling Systems.
UL 268A	Smoke Detectors for Duct Applications.
UL 464	Audible Signal Appliances.
UL 497B	Protectors for Data Communication and Fire Alarm Circuits.
UL 521	Heat Detectors for Fire Protective Signaling Systems.

- UL 632 Electrically Actuated Transmitters.
- UL 797 Electrical Metallic Tubing
- UL 864 Control Units for Fire-Protective Signaling Systems.
- UL 1638 Visual Signaling Appliances.

1.3 The following INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE) STANDARDS:

- IEEE No. 81 Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System.
- IEEE No. 142 Recommended Practice for Grounding of Industrial and Commercial Power Systems.

1.4 The following DEPARTMENT OF DEFENSE publications:

MIL-HDBK-1008C, Military Handbook FIRE PROTECTION FOR FACILITIES ENGINEERING, DESIGN, AND CONSTRUCTION. JUNE 1997

1.5 Federal Standards

FED-STD 795 Uniform Federal Accessibility Standards (UFAS)

2. GENERAL CONDITIONS

2.1 SCOPE OF WORK

Provide an approved fire alarm system and documentation as indicated. The system shall include all materials, accessories and equipment inside and outside the building necessary to provide each system complete and ready use. Install each system to give full consideration to built-in spaces, piping, electrical equipment, ductwork and all other construction and equipment and to be free from operating and maintenance difficulties. The Fire Alarm Signaling System shall be installed per NFPA 72. The Fire Alarm Signaling System when coupled to the Base Central Fire Alarm Monitoring system shall conform to NFPA 72.

2.2 ELECTRICAL/ELECTRONIC DEVICES AND COMPONENTS

Conform to respective certification requirements as defined under the current UNDERWRITERS LABORATORIES, Inc. (UL) PUBLICATIONS pertaining to equipment for, and related to, fire signaling systems. The UL label or seal, and listing in the UL Fire Protection Equipment List will be accepted as evidence that the items conform to UL requirements. The contractor shall submit proof that the items furnished under this specification conform to those requirements.

### 2.3 CLARIFICATION OF NFPA DEFINITIONS

2.3.1 The word "should," incorporated in applicable sections of NFPA and defined in NFPA 72 is to be considered as "shall" in respect to this specification. NFPA "should" recommendations are a mandatory requirement for McChord Fire Alarm Signaling Systems.

2.3.2 The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure, and maintenance or repair service, including periodically recurrent inspections and tests. The "authority having jurisdiction" shall be defined as the Base Fire Marshal, 62 Civil Engineering Squadron, McChord AFB, WA, or his authorized representative.

2.3.3 FIRE ALARM CONTROL PANEL is a control unit used to provide area fire alarm or area fire supervisory service which, when connected to the proprietary protective signaling system with the permission of the authority having jurisdiction, becomes a part of that system.

### 2.3 CONNECTION TO CENTRAL STATION

The contractor shall provide the appropriate wiring and signal from the Control Unit/Fire Alarm panel to the Fire Alarm Signaling System's Transmitter. Codes to be assigned for transmitters must be requested by the contractor, and will be provided by the government. Test equipment and personnel necessary to determine the correct signal to the transmitter will be provided by the contractor during the Acceptance Test.

### 2.5. EXISTING FIRE ALARM SIGNALING SYSTEM

Prior to the installation of any new devices, the Contractor shall test and inspect for satisfactory operation all existing initiating and indicating loops, auxiliary and supplementary circuits, and panel functions and provide a test report. This testing and inspection shall be coordinate with the Government (five working days notice required). For those items considered non-functioning, the Contractor shall provide with the report, specification sheets or written functional requirements to support the findings. The Government will repair those existing items judged defective, yet deemed necessary for a complete and working Fire Alarm Signaling System. Only after receiving Government approval of the report shall work be allowed to proceed. The Government will respond within 10 working days.

The Contractor shall assume responsibility for the existing Fire Alarm Signaling System, within the project area, upon notification of the Government's corrective actions and/or acceptance of the report. When responsibility for the existing equipment is assumed, any function and/or equipment failure shall be diagnosed and repaired by the Contractor. The Contractors responsibility shall only terminate, except for warranty of new work, when the Government accepts the completed Fire Alarm Signaling System.

## 2.6 SYSTEM

Include all wiring, raceways, pull boxes, terminal cabinets, outlet and mounting boxes, alarm initiating/indicating devices, and control equipment, and all other accessories and miscellaneous items required for an operating system even though each item is not specifically mentioned or described.

## 3. DOCUMENTATION

3.1 DOCUMENTATION: Provide all information necessary for Authorized Base Personnel to comprehend overall system logic, ease construction inspection and to calibrate, test, maintain, modify or repair the system once installed. The milestones for submittals shall be:

3.0.1 Initial Submittal prior to installation of any equipment.

3.0.2 Draft Operating and Maintenance Manual 15 working days prior to contractor established Acceptance Test date.

3.0.3 Inspection Form and Certificate of Compliance 10 working days prior to contractor established acceptance Test date.

3.0.4 Acceptance Test

3.0.5 Final Copies of the Operating and Maintenance Manuals 15 working days after completion and Government approval of the Acceptance test.

### 3.1 INITIAL SUBMITTAL

Initial Submittal documentation shall consist of as a minimum the following:

3.1.1 The Manufacturer's technical literature for the Control Unit/Fire Alarm Panel.

3.1.2 A cross reference between submittal documentation and specifications.

3.1.3 The drawings shall contain complete system wiring diagrams for the equipment furnished including device, panel, and transmitter terminal functions, floor plans showing equipment layout, riser, sequence of operation and any other details required to demonstrate that the system has been coordinated and will properly function as a unit.

3.1.4 Battery sizing calculations and methods utilized to determine calculations.

3.1.5 Proof that the Check-out Technician or Technical Supervisor have a minimum of three (3) years experience installing the described products.

3.1.6 Submittal documentation furnished under other specification sections shall be coordinated into a single package by the General contractor.

3.2 DRAFT COPY: A draft copy of the Operating and Maintenance manual containing instructional and maintenance procedures shall be furnished fifteen (15) days prior to the final acceptance test. The draft O&M Manual shall include as a minimum:

3.2.1 All information supplied in Initial Submittal Documentation.

3.2.2 Updated as-built drawings reflecting modifications and corrections made during installation.

3.2.3 Owners manual and manufacturer's installation instructions covering all equipment.

3.2.4 Maintenance/service manual for all system equipment.

3.3 INSPECTION AND TESTING FORM and CERTIFICATE OF COMPLETION:

3.3.1 The CERTIFICATE OF COMPLETION form as described by NFPA 72, paragraph 1-7.2, Fig. 1-7.2.1, shall be completed by the Contractor and presented to the Contracting Officer ten (10) days prior to the acceptance test. The Certificate of Completion form, shall include the following information: Date, Name of Property, Address, Installer/service company name, address, phone number, and representative's name, Approving agency(s) name, address, and representative, Number and type of detectors per zone for each zone, functional test of detectors, Check of all smoke detectors, Loop resistance for all fixed temperature line-type detectors, other tests as required by equipment manufacturers, Signature of tester, and such information as necessary to comply with NFPA 72. Fire Alarm System shall remain operating at the facility, after obtaining information for the Inspection and Certification forms, through the time of the Acceptance/ Performance testing, as a break-in period.

3.3.2 The INSPECTION AND TESTING FORM as described by NFPA 72, paragraph 7-5.1, Fig. 7-5.1 is used to document the testing required by NFPA 72 for detection devices. The Inspection form shall indicate the contractor's test results of the Fire Alarm system's initiating detectors, as covered in NFPA 72. The contractor doing individual testing, verified by the inspector, allows "Acceptance Testing" by a larger group to focus on testing of the system rather than individual devices.

3.4 ACCEPTANCE TEST

Shall be accomplished through completion of the Certificate of Compliance and the Inspection and Testing Form. Responsibility for operation and maintenance of the Fire Alarm system shall remain with the Contractor until completion of acceptance.

### 3.5 OPERATING AND MAINTENANCE MANUALS

Five (5) copies of the Final Operating and Maintenance Manuals consisting of the Owner's Manual, Maintenance/ Service Manual, and Drawings shall be furnished fifteen (15) days after the acceptance test. The final copies of the Operation and Maintenance Manuals shall include all final modifications and corrections accomplished during testing, including test results, and as noted from the draft Operation and Maintenance Manual. The drawings shall be produced on AutoCADD and provided on a CD ROM. The O&M Manuals shall also be provided on CD, including scanned images for catalog cuts, schematics and other such information not typed by the contractor. One set of the final drawings shall be furnished on 24" x 36" paper, using a 1/8" = 1'0" minimum scale, single or double line building floor plan. Titles shall be "Fire Alarm System, Buildings 1166 & 1167. The Operating and Maintenance Manual shall include:

3.5.1 The Owner's Manual and manufacturer's installation instructions shall include:

3.5.1.0 A detailed narrative description of the system inputs, evacuation signaling, ancillary functions, annunciation, intended sequence of operations, expansion capability, application considerations, and limitations.

3.5.1.1 Operator instructions for basic system operations including alarm acknowledgment, system reset, interpreting system output (LED's, CRT display, and printout), operation of manual evacuation signaling, and ancillary function controls, changing printer paper, etc.

3.5.1.2 A detailed description of routine maintenance and testing as required and recommended and as would be provided under a maintenance contract, including a testing and maintenance instructions for each type of device installed. This information should include:

- a) A listing of the individual system components that require periodic testing and maintenance.
- b) Step by step instructions detailing the requisite testing and maintenance procedures and the interval at which those procedures should be performed, for each type of device installed.
- c) A schedule that correlates the testing and maintenance procedures required by paragraph (2) above with the listing required by paragraph (1) above.

3.5.1.3 Detailed troubleshooting instructions for each specific type of trouble condition recognized by the system, including opens, grounds, parity errors, "loop failures," etc. These instructions should include a list of all trouble signals annunciated by the system, a description of the condition(s) that will cause those trouble signals, and step-by-step instructions describing how to isolate those problems and correct them (or call for service, as appropriate).

3.5.1.4 A service directory, including a list of names and telephone numbers for those who should be called to obtain service on the system.

3.5.2 A Maintenance/Service Manual containing complete electrical/electronic schematic(s) of devices, control unit(s)/fire alarm panel(s) and sub-components, including individual parts breakdown and identification, shall be provided. A complete technical description and theory of operation for the control unit shall be provided, including programming details, PROM data files, and software descriptions. Include spare parts data for each different item of material and equipment specified. The data shall include a complete list of parts and supplies with current unit prices and source of supply, a list of supplies that are either normally furnished at no extra cost with the purchase of equipment, or specified to be furnished, and a list of additional items recommended by the manufacture to assure efficient operation for a period of 365 days.

3.5.3 Drawings shall show, by identified symbols, all fire alarm components (control panel, audio-visual alarms, pull stations, initiating/indicating devices, etc.) and all wiring, including number, size and location of conductors, color coding of conductors and all wiring junctions. Drawings shall contain the following elements:

3.5.3.1 The floor layout will show the general layout of the facility and indicate locations of all Fire Alarm system components, auxiliary and supplementary circuits or systems devices supplied in other specification sections. Symbols utilized to depict control units, devices, and equipment shall comply with NFPA 170. The As-Built Drawings shall indicate conduit and wire routing from the Control Unit/Fire Alarm Panel to all devices and equipment connected to that panel. The As-Built drawing shall also indicate the sensitivity readings, obtained during the acceptance test, of all smoke detectors. Through annotation next to each detector or through a tabular listing, sensitivity and detector shall be clearly associated.

3.5.3.2 Diagrams shall include the following:

a) A Riser Diagram will show the number of zones (initiating and indicating), the number and type of devices in each zone, auxiliary and supplementary circuits, system's devices supplied in other specification sections and connected to a initiating zone(s), and will indicate their function, and the Central Station connection. On either the floor layout or riser diagram, the wiring sequence of devices connected to the circuit shall be shown.

b) The Control Unit/Fire Alarm Panel layout will show the location of all panel-mounted devices (Modules, Relays, etc.) associated terminal blocks or strips as well as the remote transmitter. The terminal-block/strips will show all wiring and specific terminal function (indication, initiation, auxiliary, supplementary and remote transmitter to Central Station), and the locations of spare terminals, and unassigned spaces. Jumpers, Strapping, DIP switch settings, EPROM data, and/or information of this nature necessary to insure panel

operation shall be shown. Wire identification will be shown on each terminal-block/strip and will match requirements established in paragraph 4.3, "TAGS."

3.5.3.3 A detailed sequence of operation will be provided to describe initiation and indication loop operation including auxiliary, supplementary, EMCS, and Central Station notification.

#### 4. GENERAL REQUIREMENTS

##### 4.1 STANDARD PRODUCTS

Material and equipment shall be UL listed and the latest standard products of a manufacturer regularly engaged in the manufacture of the products.

##### 4.2 NAMEPLATES

Major components of equipment shall have the manufacturer's name, address, type or style, and catalog number on a plate securely attached to the equipment.

##### 4.3 TAGS

Tags with stamped identification number shall be furnished for keys and locks. Tags shall also be furnished to identify cable and conduit runs, wiring circuits, and all spare parts (including Manufacture's Part Number) furnished for Government's stock to maintain system. All identifying tags on cable and conduit runs, wiring circuits, and all spare parts shall be matched to OPERATING AND MAINTENANCE INSTRUCTION MANUALS.

##### 4.4 KEYS AND LOCKS

All locks shall be keyed to accept a CAT 30 cut key. Keys shall match existing locks.

##### 4.5 ACCESSIBILITY

The enclosure's internal layout shall provided ample gutter space to allow sufficient and safe clearance between the enclosure and live parts of the panel equipment. If more than one modular unit is required to form a control panel, the units shall be installed in a single cabinet large enough to accommodate all units, and allow ample gutter space for interconnections of panels and field wires. The enclosure's external work space, or work clearances, shall comply with NEC Article 110. Minimum clear distance will not be less than three (3) feet.

##### 4.6 DELIVERY AND STORAGE

All equipment placed in storage shall be protected from the weather, humidity and temperature variations, dirt, dust, and other contaminants.

Part 2 MATERIALS

5. FIRE ALARM CONTROL UNIT

5.1 FIRE ALARM CONTROL UNIT: The Fire Alarm Control unit is existing and shall be maintained in operation throughout construction.

5.1.1 The system shall have the following operating features:

5.1.1.1 Electrical supervision of circuits used to activate fire extinguishing systems. Supervision shall include the coil of the releasing solenoid.

5.1.1.2 Electrical supervision of the primary power (AC) supply, presence of the battery, battery voltage, placement of alarm zone modules within the control panel, and transmitter tripping circuit integrity.

5.1.1.3 The Control Unit/Fire Alarm panel shall be equipped with sufficient auxiliary relay contacts, C/NO/NC, to provide switching as defined in paragraph 11.2.2 plus two spare identical relays.

5.1.1.4 The Control Unit/Fire Alarm panel shall be equipped with circuit protectors to protected equipment and personnel against the effects of excessive voltages and currents. The circuit protectors shall comply with UL 497B, Protectors for Data Communications and Fire Alarm Circuits.

5.1.2 The Control Unit/Fire Alarm panel, or modules within that panel, shall be a programmable type utilizing EPROM's or other non-volatile memory. Memory which requires battery power to retain data is not acceptable. Any Control Unit/Fire Alarm panel or module equipped with EPROM's or other memory devices requiring programming will include all documentation, programming equipment, and training necessary for authorized base personnel to make those programming changes, perform maintenance, and reconfigure the Fire Alarm panel.

5.2 INITIATING CIRCUITS: Initiating Circuits shall be style "D" (Reference NFPA 72), 24 VDC, four wire system, double loop. Initiating circuit shall be capable of powering a minimum of 30 smoke detectors (new and existing).

5.3 SIGNAL LINE CIRCUITS

Indicating Circuits shall be a style "3.5" (minimum) (Reference NFPA 72), 24 VDC, four wire system, double loop. Indicating circuits shall be 24 VDC.

5.4 POWER SUPPLY

Power Supply shall comply with the applicable requirements of NFPA 72. AC power input to the fire alarm power supply shall be the 120 VAC service to the building. The AC power service employed to operate the Fire Alarm System shall be on a dedicated branch circuit. The circuit and connections shall be mechanically protected. The circuit disconnection means shall be

accessible only to authorized personnel and shall be clearly marked FIRE ALARM CIRCUIT CONTROL.

#### 5.5 STANDBY BATTERIES

Batteries shall be capable of operating the fire alarm system for a minimum of 48 hours and then operating all indicating units for a minimum of 5 minutes. Batteries shall be gel-cell type with sufficient Amp-hour capacity for application plus 20 percent. Battery sizing calculations shall be included with submittals.

#### 5.6 Acceptable Equipment

The following makes and model numbers of units are acceptable:

Simplex 4100 Series  
Notifier AFP 300/400  
Spectronics Series 641

### 6. TRANSMITTER FOR REMOTE INDICATION

#### 6.1 FIRE ALARM SIGNALING SYSTEM

The system when coupled (via radio transceiver) to the Base Central Fire Alarm Monitoring System, shall conform to NFPA 72 Style 5.0 (minimum). The transceiver for remote indication will send both alarm and trouble signals generated by the fire alarm control panel and trouble conditions between the fire alarm control panel and the transceiver to the Central Station. The wiring circuits between the transceiver and the Control Unit/Fire Alarm Panel shall be supervised. The transceiver is existing and shall be maintained.

6.1.1 The transceiver shall be a four zone transceiver complete with power supply, battery backup, VHF antenna, antenna mount, lightning arrester and enclosure and coaxial cable. Transceiver shall be compatible with the existing Monaco D-700CS Radio Fire Alarm Central Station at building 6 (Fire Station). Frequency shall be 141.625 MHz.

#### 6.2 TRANSMITTER WIRING

Wiring to the Control Unit/Fire Alarm Panel shall be included in the submittals. Transmitter zone circuit wiring requirements are shown on the drawings.

### 7. HEAT DETECTORS

+Detectors shall be addressable-type. Rating, and coverage shall be as indicated on the drawings. Heat detectors shall be UL Labeled and of the fixed temperature or combination fixed temperature and rate-of-rise type with locations and temperature ratings as indicated on drawings. The Rate-of-rise type shall operate with a 15 degree F change in temperature per minute.

8. SMOKE DETECTORS: Detectors shall be addressable-type.

8.1 SMOKE DETECTORS, PHOTOELECTRIC TYPE

Detectors shall be UL 268 listed. Electronics of the detector shall be shielded to protect against false alarms from EMI and RFI. The detectors light source shall provide a minimum of 100,000 hours of operation. The detector shall have a visible lamp to indicate alarm status of the detector. Detector base shall be equipped with terminals or leads no soldering will be required. Detector will be plug-in type for easy removal with optional lock method to prevent unauthorized removal. The detector shall have a ceiling spacing of 30 ft under standard conditions (Refer to NFPA 72E).

8.2 SMOKE DETECTORS, SENSITIVITY RANGE

To assure that each smoke detector is within its listed and marked sensitivity range through out the life of the system, a test tool and method to test that sensitivity range shall be provided and consist of one of the following:

- a) A calibrated test method, or
- b) The manufacturer's calibrated sensitivity test instrument, or
- c) Listed control equipment arranged for the purpose, or
- d) A smoke detector/control unit arrangement whereby the detector causes a signal at the control unit when its sensitivity is outside its acceptable sensitivity range, or
- e) Other calibrated sensitivity test method acceptable to the authority having jurisdiction.

9. SIGNALING/INDICATING APPLIANCES

Appliances shall be a combination Audible/Visual signal device. The device shall be heavy duty, die cast metal housing with textured red enamel finish and a sound level adjustable type. The audible portion of the device shall be an electronic horn. Signaling/indicating appliances shall conform to NFPA 72 and shall be UFAS approved.

9.1 HORNS

Horns shall be electronic, polarized, interchangeable, modular and suitable for mounting over standard outlet box. Horns shall be equipped with leads or terminals for making connections, no soldering will be allowed. Horns shall have adjustable power taps for 100 db at 10 feet and 96 db at 10 feet. Individual horns shall not exceed .025 amps input current at the 96 db power tap setting. Horns shall be located as indicated, and if exterior

shall be weatherproof. Horns shall operate on a polarized 24 VDC electrically supervised circuit and be UL listed.

## 9.2 VISUAL INDICATOR

Indicator shall be integral with the horn and be a flashing strobe with high-impact thermoplastic translucent dome. The lamps shall provide a minimum of 8,000 candela with a flash rate between 60 to 120 flashes per minute. Strobe shall be capable of operating on an independent circuit or in parallel with audio device. Any individual strobe shall not exceed .042 amps input current and operate on a polarized 24 VDC electrically supervised circuit.

9.3 INPUT CURRENT: Total current of the audible/visual device will not exceed .050 amps.

## Part 3 EXECUTION

### 10.0 INSTALLATION

All work shall be installed as shown on the drawings and comply with NFPA 70 (National Electrical Code), Article 760. Installation of equipment, devices, device placement, and interconnecting wiring shall conform to NFPA as applicable. All installation work shall be done by licensed electricians.

### 10.1 WIRING

Comply with the National Electrical Code. Wiring, including ground wire shall, be installed in Electrical Metallic Tubing (EMT). Initiating, Indicating and auxiliary and supplementary circuits shall be arranged to permit disconnecting and bypassing the system at the base of each riser. External wiring between the Control Unit/Fire Alarm Panel and devices shall be a minimum of 18 gauge, color coded and labeled. Color codes and label numbers will be included with as built drawings. The wiring for the fire alarm system shall not be installed in conduits, junction boxes or outlet boxes containing lighting or power systems. The sum of the cross-sectional areas of individual conductors shall not exceed 40 percent of the interior cross-sectional area of the conduit. All conduit shall be 1/2-inch minimum. Mounting boxes for exposed work shall be steel or cast aluminum. All circuit conductors shall be identified within each enclosure where a tap, splice or termination is made.

10.2 GROUNDING: Metallic conduits, ground wires in conduit, metal splice boxes, and other non-current carrying metallic parts of equipment shall be grounded and shall have a maximum resistance to solid "earth" ground not exceeding 25 ohms under dry conditions.

10.2.1 Grounding electrodes shall be provided where existing "grounds" do not meet the specified ground resistance. Grounding electrodes shall be cone-pointed ground rods. Unless otherwise indicated, ground rods shall be driven

into the ground until tops of rods are approximately one foot below finished grade. Ground rods shall be spaced as evenly as possible at least 6 feet apart and connected 2 feet below grade.

10.2.2 Grounding connections which are buried or otherwise normally inaccessible, and excepting specifically those connections for which access for periodic testing is required, shall be made by exothermic weld. Exothermic welds shall be made strictly in accordance with the weld manufacturer's written recommendations. Welds which have "puffed up" or which show convex surfaces, indicating improper cleaning, are not acceptable. No mechanical connector is required at exothermic welds. Ground wires shall be protected by conduit where such wires run exposed above grade in non fenced-enclosed areas or are run through concrete construction.

#### Part 4 TESTING

11.0 COMMISSIONING and ACCEPTANCE of the Fire Alarm System: shall be as described in SECTION 13854M2 "Commissioning the Fire Alarm Signaling System".

#### 11.1 ACCEPTANCE TEST

Acceptance test date shall be established by the Contractor. All necessary material or personnel required to demonstrate system performance will be supplied by the Contractor. The draft Maintenance and Operational Manual with As-Builts, Inspection Form and Certificate of Compliance requirements must be met in order to conduct the Acceptance Test.

#### 11.2 CERTIFICATE OF COMPLETION

Upon successful completion of the Acceptance Test, the CERTIFICATE OF COMPLETION shall be completed and signed as required. Reference NFPA 72, Chapter 1.

END OF SECTION

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NOTE: THIS SECTION IS  
ADDED IN ITS ENTIRETY  
BY AMENDMENT 0004.

SECTION 16375

ELECTRICAL DISTRIBUTION SYSTEM, UNDERGROUND

PART 1 GENERAL

1.1 REFERENCES

The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

- ANSI C57.12.21 (1995) Requirements for Pad-Mounted, Compartmental-Type, Self-Cooled, Single-Phase Distribution Transformers with High-Voltage Bushings; (High-Voltage, 34 500 Grd Y/19 920 Volts and Below; Low-Voltage, 240/120; 167 kVA and Smaller)
- ANSI C57.12.26 (1993) Pad-Mounted Compartmental-Type, Self-Cooled, Three-Phase Distribution Transformers for Use with Separable Insulated High-Voltage Connectors, High-Voltage, 34 500 Grd Y/19 920 Volts and Below; 2500 kVa and Smaller
- ANSI C80.1 (1995) Rigid Steel Conduit - Zinc Coated
- ANSI O5.1 (1992) Specifications and Dimensions for Wood Poles

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

- ASTM A 123/A 123M (1997a) Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products
- ASTM A 153/A 153M (1995) Zinc Coating (Hot-Dip) on Iron and Steel Hardware
- ASTM B 3 (1995) Soft or Annealed Copper Wire
- ASTM B 8 (1993) Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft
- ASTM B 117 (1997) Operating Salt Spray (Fog) Apparatus
- ASTM B 496 (1992) Compact Round Concentric-Lay-Stranded Copper Conductors

ASTM D 1654 (1992) Evaluation of Painted or Coated  
Specimens Subjected to Corrosive Environments

ASSOCIATION OF EDISON ILLUMINATING COMPANIES (AEIC)

AEIC CS5 (1994) Cross-linked Polyethylene Insulated  
Shielded Power Cables Rated 5 Through 46 kV

AEIC CS6 (1996) Ethylene Propylene Rubber Insulated  
Shielded Power Cables Rated 5 Through 69 kV

FACTORY MUTUAL ENGINEERING AND RESEARCH (FM)

FM P7825a (1998) Approval Guide Fire Protection

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C2 (1997) National Electrical Safety Code

IEEE ANSI/IEEE C57.12.00 (1993) IEEE Standard General Requirements for  
Liquid-Immersed Distribution, Power, and  
Regulating Transformers

IEEE ANSI/IEEE C57.98 (1993) Guide for Transformer Impulse Tests

IEEE Std 48 (1996) Standard Test Procedures and  
Requirements for Alternating-Current Cable  
Terminations 2.5 kV through 765 kV

IEEE Std 81 (1983) Guide for Measuring Earth Resistivity,  
Ground Impedance, and Earth Surface  
Potentials of a Ground System (Part 1)

IEEE Std 404 (1993; errata) Cable Joints for Use with  
Extruded Dielectric Cable Rated 5000 V  
through 138 000 V and Cable Joints for Use  
with Laminated Dielectric Cable Rated 2500 V  
Through 500 000 V

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA FB 1 (1993) Fittings, Cast Metal Boxes and Conduit  
Bodies for Conduit and Cable Assemblies

NEMA TC 7 (1990) Smooth-Wall Coilable Polyethylene  
Electrical Plastic Duct

NEMA WC 7 (1991; Rev 1) Cross-Linked-Thermosetting-  
Polyethylene- Insulated Wire and Cable for  
the Transmission and Distribution of  
Electrical Energy

NEMA WC 8 (1991; Rev 1; Rev 2) Ethylene-Propylene-  
Rubber-Insulated Wire and Cable for the  
Transmission and Distribution of Electrical  
Energy

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA)

NFPA 70 (1999) National Electrical Code

UNDERWRITERS LABORATORIES (UL)

UL 6 (1997) Rigid Metal Conduit

UL 467 (1993; Rev thru Aug 1996) Grounding and  
Bonding Equipment

UL 486B (1997; Rev Jun 1997) Wire Connectors for Use  
with Aluminum Conductors

UL 514A (1996; Rev Jul 1998) Metallic Outlet Boxes

UL 651 (1995; Rev thru Oct 1998) Schedule 40 and 80  
Rigid PVC Conduit

UL 1072 (1995; Rev Mar 1998) Medium-Voltage Power  
Cable

UL 1242 (1996; Rev Apr 1997) Intermediate Metal  
Conduit

UL 1684 (1996) Reinforced Thermosetting Resin Conduit  
(RTRC) and Fittings

1.2 GENERAL REQUIREMENTS

1.2.1 Terminology

Terminology used in this specification is as defined in IEEE Std 100.

1.2.2 Service Conditions

Items provided under this section shall be specifically suitable for the following service conditions. Seismic details shall conform to Sections 13080 SEISMIC PROTECTION FOR MISCELLANEOUS EQUIPMENT and 16070 SEISMIC PROTECTION FOR ELECTRICAL EQUIPMENT.

a. Seismic Parameters Zone 3

1.3 SUBMITTALS

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Electrical Distribution System ; G, RE

Detail drawings consisting of equipment drawings, illustrations, schedules, instructions, diagrams manufacturers standard installation drawings and other information necessary to define the installation and enable the Government to check conformity with the requirements of the contract drawings.

If departures from the contract drawings are deemed necessary by the Contractor, complete details of such departures shall be included with the detail drawings. Approved departures shall be made at no additional cost to the Government.

Detail drawings shall show how components are assembled, function together and how they will be installed on the project. Data and drawings for component parts of an item or system shall be coordinated and submitted as a unit. Data and drawings shall be coordinated and included in a single submission. Multiple submissions for the same equipment or system are not acceptable except where prior approval has been obtained from the Contracting Officer. In such cases, a list of data to be submitted later shall be included with the first submission. Detail drawings shall consist of the following:

a. Detail drawings showing physical arrangement, construction details, connections, finishes, materials used in fabrication, provisions for conduit or busway entrance, access requirements for installation and maintenance, physical size, electrical characteristics, foundation and support details, and equipment weight. Drawings shall be drawn to scale and/or dimensioned. All optional items shall be clearly identified as included or excluded.

b. Internal wiring diagrams of equipment showing wiring as actually provided for this project. External wiring connections shall be clearly identified.

Detail drawings shall as a minimum depict the installation of the following items:

a. Medium-voltage cables and accessories including cable installation plan.

a. Transformers.

As-Built Drawings ; G, RE

The as-built drawings shall be a record of the construction as installed. The drawings shall include the information shown on the contract drawings as well as deviations, modifications, and changes from the contract drawings, however minor. The as-built drawings shall be a full sized set of prints marked to reflect deviations, modifications, and changes. The as-built drawings shall be

complete and show the location, size, dimensions, part identification, and other information. Additional sheets may be added. The as-built drawings shall be jointly inspected for accuracy and completeness by the Contractor's quality control representative and by the Contracting Officer prior to the submission of each monthly pay estimate. Upon completion of the work, the Contractor shall provide three full sized sets of the marked prints to the Contracting Officer for approval. If upon review, the as-built drawings are found to contain errors and/or omissions, they will be returned to the Contractor for correction. The Contractor shall correct and return the as-built drawings to the Contracting Officer for approval within 10 calendar days from the time the drawings are returned to the Contractor.

#### SD-03 Product Data

Fault Current Analysis ; G, RE  
Protective Device ; G, RE  
Coordination Study ; G, RE

The study shall be submitted with protective device equipment submittals. No time extension or similar contract modifications will be granted for work arising out of the requirements for this study. Approval of protective devices proposed shall be based on recommendations of this study. The Government shall not be held responsible for any changes to equipment, device ratings, settings, or additional labor for installation of equipment or devices ordered and/or procured prior to approval of the study.

Material and Equipment ; G, RE

A complete itemized listing of equipment and materials proposed for incorporation into the work. Each entry shall include an item number, the quantity of items proposed, and the name of the manufacturer of each such item.

#### SD-06 Test Reports

Factory Tests

Certified factory test reports shall be submitted when the manufacturer performs routine factory tests, including tests required by standards listed in paragraph REFERENCES. Results of factory tests performed shall be certified by the manufacturer, or an approved testing laboratory, and submitted within 7 days following successful completion of the tests. The manufacturer's pass-fail criteria for tests specified in paragraph FIELD TESTING shall be included.

Field Testing ; G, RE

A proposed field test plan, 30 days prior to testing the installed system. No field test shall be performed until the test plan is approved. The test plan shall consist of complete field

test procedures including tests to be performed, test equipment required, and tolerance limits.

Operating Tests ; G, RE

Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of three rings, including a separate section for each test. Sections shall be separated by heavy plastic dividers with tabs.

- a. A list of equipment used, with calibration certifications.
- b. A copy of measurements taken.
- c. The dates of testing.
- d. The equipment and values to be verified.
- e. The condition specified for the test.
- f. The test results, signed and dated.
- g. A description of adjustments made.

Cable Installation

Six copies of the information described below in 8-1/2 by 11 inch binders having a minimum of three rings from which material may readily be removed and replaced, including a separate section for each cable pull. Sections shall be separated by heavy plastic dividers with tabs, with all data sheets signed and dated by the person supervising the pull.

- a. Site layout drawing with cable pulls numerically identified.
- b. A list of equipment used, with calibration certifications. The manufacturer and quantity of lubricant used on pull.
- c. The cable manufacturer and type of cable.
- d. The dates of cable pulls, time of day, and ambient temperature.
- e. The length of cable pull and calculated cable pulling tensions.
- f. The actual cable pulling tensions encountered during pull.

SD-10 Operation and Maintenance Data

Electrical Distribution System ; G, RE

Six copies of operation and maintenance manuals, within 7 calendar days following the completion of tests and including assembly,

installation, operation and maintenance instructions, spare parts data which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked. Manuals shall also include data outlining detailed procedures for system startup and operation, and a troubleshooting guide which lists possible operational problems and corrective action to be taken. A brief description of all equipment, basic operating features, and routine maintenance requirements shall also be included. Documents shall be bound in a binder marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent contract information and contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

Three additional copies of the instructions manual shall be provided within 30 calendar days following the manuals.

#### 1.4 DELIVERY, STORAGE, AND HANDLING

Devices and equipment shall be visually inspected by the Contractor when received and prior to acceptance from conveyance. Stored items shall be protected from the environment in accordance with the manufacturer's published instructions. Damaged items shall be replaced. Oil filled transformers shall be stored in accordance with the manufacturer's requirements. Wood poles held in storage for more than 2 weeks shall be stored in accordance with ANSI O5.1. Handling of wood poles shall be in accordance with ANSI O5.1, except that pointed tools capable of producing indentations more than 1 inch in depth shall not be used. Metal poles shall be handled and stored in accordance with the manufacturer's instructions.

#### 1.5 EXTRA MATERIALS

One additional spare fuse or fuse element for each furnished fuse or fuse element shall be delivered to the contracting officer when the electrical system is accepted. Two complete sets of all special tools required for maintenance shall be provided, complete with a suitable tool box. Special tools are those that only the manufacturer provides, for special purposes (to access compartments, or operate, adjust, or maintain special parts).

### PART 2 PRODUCTS

#### 2.1 STANDARD PRODUCT

Material and equipment shall be the standard product of a manufacturer regularly engaged in the manufacture of the product and shall essentially duplicate items that have been in satisfactory use for at least 2 years prior to bid opening. Items of the same classification shall be identical including equipment, assemblies, parts, and components.

#### 2.2 CORROSION PROTECTION

### 2.2.1 Aluminum Materials

Aluminum shall not be used in contact with earth or concrete. Where aluminum conductors are connected to dissimilar metal, fittings conforming to UL 486B shall be used.

### 2.2.2 Ferrous Metal Materials

#### 2.2.2.1 Hardware

Ferrous metal hardware shall be hot-dip galvanized in accordance with ASTM A 153/A 153M and ASTM A 123/A 123M.

#### 2.2.2.2 Equipment

Equipment and component items, including but not limited to transformer stations and ferrous metal luminaries not hot-dip galvanized or porcelain enamel finished, shall be provided with corrosion-resistant finishes which shall withstand 480 hours of exposure to the salt spray test specified in ASTM B 117 without loss of paint or release of adhesion of the paint primer coat to the metal surface in excess of 1/16 inch from the test mark. The scribed test mark and test evaluation shall be in accordance with ASTM D 1654 with a rating of not less than 7 in accordance with TABLE 1, (procedure A). Cut edges or otherwise damaged surfaces of hot-dip galvanized sheet steel or mill galvanized sheet steel shall be coated with a zinc rich paint conforming to the manufacturer's standard.

### 2.2.3 Finishing

Painting required for surfaces not otherwise specified and finish painting of items only primed at the factory shall be as specified in Section 09900 PAINTING, GENERAL.

## 2.3 CABLES

Cables shall be single conductor type unless otherwise indicated.

### 2.3.1 Medium-Voltage Cables

#### 2.3.1.1 General

Cable construction shall be Type MV, conforming to NFPA 70 and UL 1072 concentric neutral underground distribution cable conforming to AEIC CS5 and NEMA WC 7. Cables shall be manufactured for use in duct applications.

#### 2.3.1.2 Ratings

Cables shall be rated for a circuit voltage 15 kV.

#### 2.3.1.3 Conductor Material

Underground cables shall be soft drawn copper complying with ASTM B 3 and ASTM B 8 for regular concentric and compressed stranding or ASTM B 496 for compact stranding.

#### 2.3.1.4 Insulation

Cable insulation shall be cross-linked thermosetting polyethylene (XLP) insulation conforming to the requirements of NEMA WC 7 and AEIC CS5. A 133 percent insulation level shall be used on 15 kV rated cables.

#### 2.3.1.5 Shielding

Cables rated for 2 kV and above shall have a semiconducting conductor shield, a semiconducting insulation shield, and an overall copper tape shield for each phase. The shield tape shall be sized to meet IEEE C2 requirements for a ground fault availability of 100,000 amperes.

#### 2.3.1.6 Jackets

Cables shall be provided with a PVC polyethylene jacket.

#### 2.3.2 Low-Voltage Cables

Cables shall be rated 600 volts and shall conform to the requirements of NFPA 70, and must be UL listed for the application or meet the applicable section of either ICEA or NEMA standards.

##### 2.3.2.1 Conductor Material

Underground cables shall be annealed copper complying with ASTM B 3 and ASTM B 8. Intermixing of copper and aluminum conductors is not permitted.

##### 2.3.2.2 Insulation

Insulation must be in accordance with NFPA 70, and must be UL listed for the application or meet the applicable sections of either ICEA, or NEMA standards.

##### 2.3.2.3 Jackets

Multiconductor cables shall have an overall PVC outer jacket.

##### 2.3.2.4 In Duct

Cables shall be single-conductor cable, in accordance with NFPA 70.

#### 2.4 CONDUIT AND DUCTS

Duct lines shall be concrete-encased, thin-wall type

##### 2.4.1 Metallic Conduit

Intermediate metal conduit shall comply with UL 1242. Rigid galvanized steel conduit shall comply with UL 6 and ANSI C80.1. Metallic conduit fittings and outlets shall comply with UL 514A and NEMA FB 1.

#### 2.4.2 Nonmetallic Ducts

##### 2.4.2.1 Concrete Encased Ducts

UL 651 Schedule 40

##### 2.4.3 Conduit Sealing Compound

Compounds for sealing ducts and conduit shall have a putty-like consistency workable with the hands at temperatures as low as 35 degrees F, shall neither slump at a temperature of 300 degrees F, nor harden materially when exposed to the air. Compounds shall adhere to clean surfaces of fiber or plastic ducts; metallic conduits or conduit coatings; concrete, masonry, or lead; any cable sheaths, jackets, covers, or insulation materials; and the common metals. Compounds shall form a seal without dissolving, noticeably changing characteristics, or removing any of the ingredients. Compounds shall have no injurious effect upon the hands of workmen or upon materials.

#### 2.5 TRANSFORMERS, SUBSTATIONS, AND SWITCHGEAR

Transformers, shall be of the outdoor type having the ratings and arrangements indicated. Medium-voltage ratings of cable terminations shall be 15kV between phases for 133 percent insulation level.

##### 2.5.1 Pad-Mounted Transformers

Pad-mounted transformers shall comply with ANSI C57.12.26 and shall be of the radial. Pad-mounted transformer stations shall be assembled and coordinated by one manufacturer and each transformer station shall be shipped as a complete unit so that field installation requirements are limited to mounting each unit on a concrete pad and connecting it to primary and secondary lines. Stainless steel pins and hinges shall be provided. Barriers shall be provided between high- and low-voltage compartments. High-voltage compartment doors shall be interlocked with low-voltage compartment doors to prevent access to any high-voltage section unless its associated low-voltage section door has first been opened. Compartments shall be sized to meet the specific dimensional requirements of ANSI C57.12.26. Pentahead locking bolts shall be provided with provisions for a padlock.

##### 2.5.1.1 High-Voltage Compartments

The high-voltage compartment shall be dead-front construction. Primary switching and protective devices shall include loadbreak switching, drawout, dry-well-mounted, current-limiting fuses oil-immersed, current-limiting, bayonet-type fuses, medium-voltage separable loadbreak connectors, universal bushing wells and inserts or integral one piece bushings and surge arresters. Fuses shall comply with the requirements of paragraph METERING AND PROTECTIVE DEVICES. The switch shall be mounted inside transformer tank with switch operating handle located in high-voltage compartment and equipped with metal loop for hook stick operation. Fuses shall be interlocked with switches so that fuses can be removed only when the associated switch is in the "OPEN" position. Adjacent to medium-voltage cable connections, a nameplate or equivalent stencilled inscription shall be

provided inscribed "DO NOT OPEN CABLE CONNECTORS UNLESS SWITCH IS OPEN."  
 Surge arresters shall be fully insulated and configured to terminate on the  
 same bushing as the primary cable by means of a loadbreak, feed-through  
 bushing insert.

2.5.1.2 Load-Break Switch

Loop feed sectionalizer switches: Provide three, two-position, oil-immersed  
 type switches to permit closed transition loop feed and sectionalizing.  
 Each switch shall be rated at 15kV, 95 kV BIL, with a continuous current  
 rating and load-break rating of 200 amperes, and a make-and-latch rating of  
 10,000 rms amperes symmetrical. Locate the switch handle in the high-  
 voltage compartment. Operation of switches shall be as follows:

-0.33

1	Line A connected to Line B and both lines connected to transformer	X	X	X
2	Transformer connected to Line A only	X	X	X
3	Transformer connected to Line B only	X	X	X
4	Transformer open and loop closed	X	X	X
5	Transformer open and loop open	X	X	X

2.5.1.3 Transformer Tank Sections

Transformers shall comply with IEEE ANSI/IEEE C57.12.00, ANSI C57.12.21, and  
 ANSI C57.12.26 and shall be of the less-flammable, liquid-insulated type  
 with high molecular-weight hydrocarbon liquid. Transformers shall be  
 suitable for outdoor use and shall have 2 separate windings per phase.  
 Standard NEMA primary taps shall be provided. Where primary taps are not  
 specified, 4, 2-1/2 percent rated kVA high-voltage taps shall be provided 2  
 above and 2 below rated, primary voltage. Operating handles for primary tap  
 changers for de-energized operation shall be located within high-voltage  
 compartments, externally to transformer tanks. Adjacent to the tap changer  
 operating handle, a nameplate or equivalent stenciled inscription shall be  
 provided and inscribed "DO NOT OPERATE UNDER LOAD." Transformer ratings at  
 60 Hz shall be as follows:

Three-phase capacity.....75 kVA.

Impedance.....5½%  
Temperature Rise.....65 degrees C.  
High-voltage winding.....13.8KV volts.  
High-voltage winding connections.....delta.  
Low-voltage winding.....480 volts.  
Low-voltage winding connections.....wye.

#### 2.5.1.4 Low-Voltage Cable Compartments

Neutrals shall be provided with fully-insulated bushings. Clamp type cable terminations, suitable for copper conductors entering from below, shall be provided as necessary.

#### 2.5.1.5 Accessories

High-voltage warning signs shall be permanently attached to each side of transformer stations. Voltage warning signs shall comply with IEEE C2. Copper-faced steel or stainless steel ground connection pads shall be provided in both the high- and low-voltage compartments. Dial-type thermometer, liquid-level gauge, and drain valve with built-in sampling device shall be provided for each transformer station. Insulated-bushing-type parking stands shall be provided adjacent to each separable load-break elbow to provide for cable isolation during sectionalizing operations.

### 2.6 GROUNDING AND BONDING

#### 2.6.1 Driven Ground Rods

Ground rods shall be copper-clad steel conforming to UL 467 not less than 3/4 inch in diameter by 10 feet in length. Sectional type rods may be used.

#### 2.6.2 Grounding Conductors

Grounding conductors shall be bare, except where installed in conduit with associated phase conductors. Insulated conductors shall be of the same material as phase conductors and green color-coded, except that conductors shall be rated no more than 600 volts. Bare conductors shall be ASTM B 8 soft-drawn unless otherwise indicated. Aluminum is not acceptable.

### 2.7 CONCRETE AND REINFORCEMENT

Concrete work shall have minimum 3000 psi compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete reinforcing shall be as specified in Section 03200 CONCRETE REINFORCEMENT.

### 2.8 PADLOCKS

Padlocks shall comply with Section 08700 'Builders' Hardware

## 2.9 CABLE FIREPROOFING SYSTEMS

Cable fireproofing systems shall be listed in FM P7825a as a fire-protective coating or tape approved for grouped electrical conductors and shall be suitable for application on the type of medium-voltage cables provided. After being fully cured, materials shall be suitable for use where exposed to oil, water, gases, salt water, sewage, and fungus and shall not damage cable jackets or insulation. Asbestos materials are not acceptable.

### 2.9.1 Fireproof Coating

Cable fireproofing coatings shall be compounded of water-based thermoplastic resins, flame-retardant chemicals, and inorganic noncombustible fibers and shall be suitable for the application methods used. Coatings applied on bundled cables shall have a derating factor of less than 5 percent, and a dielectric strength of 95 volts per mil minimum after curing.

### 2.9.2 Fireproofing Tape

Fireproofing tape shall be at least 2 inches wide and shall be a flexible, conformable, polymeric, elastomer tape designed specifically for fireproofing cables.

### 2.9.3 Plastic Tape

Preapplication plastic tape shall be pressure sensitive, 10 mil thick, conforming to UL 510.

## 2.10 FACTORY TESTS

Factory tests shall be performed, as follows, in accordance with the applicable publications and with other requirements of these specifications. The Contracting Officer shall be notified at least 10 days before the equipment is ready for testing. The Contracting Officer reserves the right to witness the tests.

- a. Transformers: Manufacturer's standard routine and other tests in accordance with IEEE ANSI/IEEE C57.12.00.
- b. Transformers rated 200 kVA and above: Reduced full-wave, chopped-wave, and full-wave impulse test on each line and neutral terminal, in accordance with IEEE ANSI/IEEE C57.98.

## PART 3 EXECUTION

### 3.1 GENERAL INSTALLATION REQUIREMENTS

Equipment and devices shall be installed and energized in accordance with the manufacturer's published instructions. Steel conduits installed underground shall be installed and protected from corrosion in conformance with the requirements of Section 16415 ELECTRICAL WORK, INTERIOR. Except as covered herein, excavation, trenching, and backfilling shall conform to the requirements of Section 02316 EXCAVATION, TRENCHING, AND BACKFILLING FOR

UTILITIES SYSTEMS. Concrete work shall have minimum 3000 psi compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE.

### 3.1.1 Conformance to Codes

The installation shall comply with the requirements and recommendations of NFPA 70 and IEEE C2 as applicable.

### 3.1.2 Verification of Dimensions

The Contractor shall become familiar with details of the work, shall verify dimensions in the field, and shall advise the Contracting Officer of any discrepancy before performing any work.

## 3.2 CABLE INSTALLATION

The Contractor shall obtain from the manufacturer an installation manual or set of instructions which addresses such aspects as cable construction, insulation type, cable diameter, bending radius, cable temperature, lubricants, coefficient of friction, conduit cleaning, storage procedures, moisture seals, testing for and purging moisture, etc. The Contractor shall then prepare a checklist of significant requirements which shall be submitted along with the manufacturers instructions in accordance with SUBMITTALS.

### 3.2.1 Cable Installation Plan and Procedure

Cable shall be installed strictly in accordance with the cable manufacturer's recommendations. Each circuit shall be identified by means of a fiber, laminated plastic, or non-ferrous metal tags, or approved equal, in each manhole, handhole, junction box, and each terminal. Each tag shall contain the following information; cable type, conductor size, circuit number, circuit voltage, cable destination and phase identification.

#### 3.2.1.1 Cable Inspection

The cable reel shall be inspected for correct storage positions, signs of physical damage, and broken end seals. If end seal is broken, moisture shall be removed from cable in accordance with the cable manufacturer's recommendations.

#### 3.2.1.2 Duct Cleaning

Duct shall be cleaned with an assembly that consists of a flexible mandrel (manufacturers standard product in lengths recommended for the specific size and type of duct) that is 1/4 inch less than inside diameter of duct, 2 wire brushes, and a rag. The cleaning assembly shall be pulled through conduit a minimum of 2 times or until less than a volume of 8 cubic inches of debris is expelled from the duct.

#### 3.2.1.3 Duct Lubrication

The cable lubricant shall be compatible with the cable jacket for cable that is being installed. Application of lubricant shall be in accordance with lubricant manufacturer's recommendations.

#### 3.2.1.4 Cable Installation

The Contractor shall provide a cable feeding truck and a cable pulling winch as required. The Contractor shall provide a pulling grip or pulling eye in accordance with cable manufacturer's recommendations. The pulling grip or pulling eye apparatus shall be attached to polypropylene or manilla rope followed by lubricant front end packs and then by power cables. A dynamometer shall be used to monitor pulling tension. Pulling tension shall not exceed cable manufacturer's recommendations. The Contractor shall not allow cables to cross over while cables are being fed into duct. For cable installation in cold weather, cables shall be kept at 50 degrees F temperature for at least 24 hours before installation.

#### 3.2.1.5 Cable Installation Plan

The Contractor shall submit a cable installation plan for all cable pulls in accordance with the detail drawings portion of paragraph SUBMITTALS. Cable installation plan shall include:

- a. Site layout drawing with cable pulls identified in numeric order of expected pulling sequence and direction of cable pull.
- b. List of cable installation equipment.
- c. Lubricant manufacturer's application instructions.
- d. Procedure for resealing cable ends to prevent moisture from entering cable.
- e. Cable pulling tension calculations of all cable pulls.
- f. Cable percentage conduit fill.
- g. Cable sidewall thrust pressure.
- h. Cable minimum bend radius and minimum diameter of pulling wheels used.
- i. Cable jam ratio.
- j. Maximum allowable pulling tension on each different type and size of conductor.
- k. Maximum allowable pulling tension on pulling device.

#### 3.2.2 Duct Line

Cables shall be installed in duct lines where indicated. Cable splices in low-voltage cables shall be made in manholes and handholes only, except as otherwise noted. Cable joints in medium-voltage cables shall be made in

manholes or approved pullboxes only. Neutral and grounding conductors shall be installed in the same duct with their associated phase conductors.

### 3.2.3 Electric Manholes

Cables shall be routed around the interior walls and securely supported from walls on cables racks. Cable routing shall minimize cable crossover, provide access space for maintenance and installation of additional cables, and maintain cable separation in accordance with IEEE C2.

### 3.3 CABLE JOINTS

Medium-voltage cable joints shall be made by qualified cable splicers only. Qualifications of cable splicers shall be submitted in accordance with paragraph SUBMITTALS. Shields shall be applied as required to continue the shielding system through each entire cable joint. Shields may be integrally molded parts of preformed joints. Shields shall be grounded at each joint or in accordance with manufacturer's recommended practice. Cable joints shall provide insulation and jacket equivalent to that of the associated cable. Armored cable joints shall be enclosed in compound-filled, cast-iron or alloy, splice boxes equipped with stuffing boxes and armor clamps of a suitable type and size for the cable being installed.

### 3.4 FIREPROOFING

Each medium-voltage cable and conductor in manholes shall be fire-proofed for their entire length within the manhole. Where cables and conductors have been lubricated to enhance pulling into ducts, the lubricant shall be removed from cables and conductors exposed in the manhole before fireproofing.

#### 3.4.1 Tape Method

Before application of fireproofing tape, plastic tape wrapping shall be applied over exposed metallic items such as the cable ground wire, metallic outer covering, or armor to minimize the possibility of corrosion from the fireproofing materials and moisture. Before applying fireproofing tape, irregularities of cables, such as at cable joints, shall be evened out with insulation putty. A flexible conformable polymeric elastomer fireproof tape shall be wrapped tightly around each cable spirally in 1/2 lapped wrapping or in 2 butt-jointed wrappings with the second wrapping covering the joints of the first.

#### 3.4.2 Sprayable Method

Manholes shall be power ventilated until coatings are dry and dewatered and the coatings are cured. Ventilation requirements shall be in accordance with the manufacturer's instruction, but not less than 10 air changes per hour shall be provided. Cable coatings shall be applied by spray, brush, or glove to a wet film thickness that reduces to the dry film thickness approved for fireproofing by FM P7825a. Application methods and necessary safety precautions shall be in accordance with the manufacturers instructions. After application, cable coatings shall be dry to the touch in 1 to 2 hours and fully cured in 48 hours, except where the manufacturer

has stated that because of unusual humidity or temperature, longer periods may be necessary.

### 3.5 DUCT LINES

#### 3.5.1 Requirements

Numbers and sizes of ducts shall be as indicated. Duct lines shall be laid with a minimum slope of 4 inches per 100 feet. Depending on the contour of the finished grade, the high-point may be at a terminal, a manhole, a handhole, or between manholes or handholes. Short-radius manufactured 90-degree duct bends may be used only for pole or equipment risers, unless specifically indicated as acceptable. The minimum manufactured bend radius shall be 18 inches for ducts of less than 3 inch diameter, and 36 inches for ducts 3 inches or greater in diameter. Otherwise, long sweep bends having a minimum radius of 25 feet shall be used for a change of direction of more than 5 degrees, either horizontally or vertically. Both curved and straight sections may be used to form long sweep bends, but the maximum curve used shall be 30 degrees and manufactured bends shall be used. Ducts shall be provided with end bells whenever duct lines terminate in manholes or handholes.

#### 3.5.2 Treatment

Ducts shall be kept clean of concrete, dirt, or foreign substances during construction. Field cuts requiring tapers shall be made with proper tools and match factory tapers. A coupling recommended by the duct manufacturer shall be used whenever an existing duct is connected to a duct of different material or shape. Ducts shall be stored to avoid warping and deterioration with ends sufficiently plugged to prevent entry of any water or solid substances. Ducts shall be thoroughly cleaned before being laid. Plastic ducts shall be stored on a flat surface and protected from the direct rays of the sun.

#### 3.5.3 Concrete Encasement

Ducts requiring concrete encasements shall comply with NFPA 70, except that electrical duct bank configurations for ducts 6 inches in diameter shall be determined by calculation and as shown on the drawings. The separation between adjacent electric power and communication ducts shall conform to IEEE C2. Duct line encasements shall be monolithic construction. Where a connection is made to a previously poured encasement, the new encasement shall be well bonded or doweled to the existing encasement. The Contractor shall submit proposed bonding method for approval in accordance with the detail drawing portion of paragraph SUBMITTALS. At any point, except railroad and airfield crossings, tops of concrete encasements shall be not less than the cover requirements listed in NFPA 70. At railroad and airfield crossings, duct lines shall be encased with concrete and reinforced as indicated to withstand specified surface loadings. Tops of concrete encasements shall be not less than 5 feet below tops of rails or airfield paving unless otherwise indicated. Where ducts are jacked under existing pavement, rigid steel conduit will be installed because of its strength. To protect the corrosion-resistant conduit coating, predrilling or installing conduit inside a larger iron pipe sleeve (jack-and-sleeve) is required. For

crossings of existing railroads and airfield pavements greater than 50 feet in length, the predrilling method or the jack-and-sleeve method will be used. Separators or spacing blocks shall be made of steel, concrete, plastic, or a combination of these materials placed not farther apart than 4 feet on centers. Ducts shall be securely anchored to prevent movement during the placement of concrete and joints shall be staggered at least 6 inches vertically.

#### 3.5.4 Installation of Couplings

Joints in each type of duct shall be made up in accordance with the manufacturer's recommendations for the particular type of duct and coupling selected and as approved.

##### 3.5.4.1 Plastic Duct

Duct joints shall be made by brushing a plastic solvent cement on insides of plastic coupling fittings and on outsides of duct ends. Each duct and fitting shall then be slipped together with a quick 1/4-turn twist to set the joint tightly.

#### 3.5.5 Duct Line Markers

Duct line markers shall be provided [as indicated] [at the ends of long duct line stubouts or for other ducts whose locations are indeterminate because of duct curvature or terminations at completely below-grade structures]. In addition to markers, a 5 mil brightly colored plastic tape, not less than 3 inches in width and suitably inscribed at not more than 10 feet on centers with a continuous metallic backing and a corrosion-resistant 1 mil metallic foil core to permit easy location of the duct line, shall be placed approximately 12 inches below finished grade levels of such lines.

### 3.6 PAD-MOUNTED EQUIPMENT INSTALLATION

Pad-mounted equipment, shall be installed on concrete pads in accordance with the manufacturer's published, standard installation drawings and procedures, except that they shall be modified to meet the requirements of this document. Units shall be installed so that they do not damage equipment or scratch painted or coated surfaces. After installation, surfaces shall be inspected and scratches touched up with a paint or coating provided by the manufacturer especially for this purpose.

#### 3.6.1 Concrete Pads

##### 3.6.1.1 Construction

Concrete pads for pad-mounted electrical equipment shall be poured-in-place. Pads shall be constructed as indicated, except that exact pad dimensions and mounting details are equipment specific and are the responsibility of the Contractor. Tops of concrete pads shall be level and shall project 4 inches above finished paving or grade and sloped to drain. Edges of concrete pads shall have 3/4 inch chamfer. Conduits for primary, secondary, and grounding conductors shall be set in place prior to placement of concrete pads. Where grounding electrode conductors are installed through concrete pads, PVC conduit sleeves shall be installed through the concrete to provide physical

protection. To facilitate cable installation and termination, the concrete pad shall be provided with a rectangular hole below the primary and secondary compartments, sized in accordance with the manufacturer's recommended dimensions. Upon completion of equipment installation the rectangular hole shall be filled with masonry grout.

#### 3.6.1.2 Concrete and Reinforcement

Concrete work shall have minimum 3000 psi compressive strength and conform to the requirements of Section 03300 CAST-IN-PLACE STRUCTURAL CONCRETE. Concrete pad reinforcement shall be in accordance with Section 03200 CONCRETE REINFORCEMENT.

#### 3.6.1.3 Sealing

When the installation is complete, the Contractor shall seal all conduit and other entries into the equipment enclosure with an approved sealing compound. Seals shall be of sufficient strength and durability to protect all energized live parts of the equipment from rodents, insects, or other foreign matter.

#### 3.6.2 Padlocks

Padlocks shall be provided for pad-mounted equipment and for each fence gate. Padlocks shall be keyed [alike] [as directed by the Contracting Officer].

### 3.7 CONNECTIONS TO BUILDINGS

Cables shall be extended into the various buildings as indicated, and shall be connected to the first applicable termination point in each building. Interfacing with building interior conduit systems shall be at conduit stubouts terminating 5 feet outside of a building and 3 feet below finished grade as specified and provided under Section 16415 ELECTRICAL WORK, INTERIOR. After installation of cables, conduits shall be sealed to prevent entrance of moisture or gases into buildings.

### 3.8 GROUNDING

A ground ring consisting of the indicated configuration of bare copper conductors and driven ground rods shall be installed around pad-mounted equipment as shown. Equipment frames of metal-enclosed equipment, and other noncurrent-carrying metal parts, such as cable shields, cable sheaths and armor, and metallic conduit shall be grounded. At least 2 connections shall be provided from a transformer, and a unit substation to the ground mat. Metallic frames and covers of handholes and pull boxes shall be grounded by use of a braided, copper ground strap with equivalent ampacity of No. 6 AWG.

#### 3.8.1 Grounding Electrodes

Grounding electrodes shall be installed as shown on the drawings and as follows:

a. Driven rod electrodes - Unless otherwise indicated, ground rods shall be driven into the earth until the tops of the rods are approximately 1 foot below finished grade.

b. Ground ring - A ground ring shall be installed as shown consisting of bare copper conductors installed [12] [18] [24] inches, plus or minus 3 inches, below finished top of soil grade. Ground ring conductors shall be [sized as shown] [No. 2 AWG, minimum].

### 3.8.2 Grounding and Bonding Connections

Connections above grade shall be made by the fusion-welding process or with bolted solderless connectors, in compliance with UL 467, and those below grade shall be made by a fusion-welding process. Where grounding conductors are connected to aluminum-composition conductors, specially treated or lined copper-to-aluminum connectors suitable for this purpose shall be used.

### 3.8.3 Grounding and Bonding Conductors

Grounding and bonding conductors include conductors used to bond transformer enclosures and equipment frames to the grounding electrode system. Grounding and bonding conductors shall be sized as shown, and located to provide maximum physical protection. Bends greater than 45 degrees in ground conductors are not permitted. Routing of ground conductors through concrete shall be avoided. When concrete penetration is necessary, nonmetallic conduit shall be cast flush with the points of concrete entrance and exit so as to provide an opening for the ground conductor, and the opening shall be sealed with a suitable compound after installation.

### 3.8.4 Manhole, Handhole, or Concrete Pullbox Grounding

Ground rods installed in manholes, handholes, or concrete pullboxes shall be connected to cable racks, cable-pulling irons, the cable shielding, metallic sheath, and armor at each cable joint or splice by means of a No. 4 AWG braided tinned copper wire. Connections to metallic cable sheaths shall be by means of tinned terminals soldered to ground wires and to cable sheaths. Care shall be taken in soldering not to damage metallic cable sheaths or shields. Ground rods shall be protected with a double wrapping of pressure-sensitive plastic tape for a distance of 2 inches above and 6 inches below concrete penetrations. Grounding electrode conductors shall be neatly and firmly attached to manhole or handhole walls and the amount of exposed bare wire shall be held to a minimum.

## 3.9 FIELD TESTING

### 3.9.1 General

Field testing shall be performed in the presence of the Contracting Officer. The Contractor shall notify the Contracting Officer 10 days prior to conducting tests. The Contractor shall furnish all materials, labor, and equipment necessary to conduct field tests. The Contractor shall perform all tests and inspections recommended by the manufacturer unless

specifically waived by the Contracting Officer. The Contractor shall maintain a written record of all tests which includes date, test performed, personnel involved, devices tested, serial number and name of test equipment, and test results. Field test reports shall be signed and dated by the Contractor.

### 3.9.2 Safety

The Contractor shall provide and use safety devices such as rubber gloves, protective barriers, and danger signs to protect and warn personnel in the test vicinity. The Contractor shall replace any devices or equipment which are damaged due to improper test procedures or handling.

### 3.9.3 Ground-Resistance Tests

The resistance of each grounding electrode shall be measured using the fall-of-potential method defined in IEEE Std 81. Ground resistance measurements shall be made before the electrical distribution system is energized and shall be made in normally dry conditions not less than 48 hours after the last rainfall. Resistance measurements of separate grounding electrode systems shall be made before the systems are bonded together below grade. The combined resistance of separate systems may be used to meet the required resistance, but the specified number of electrodes must still be provided.

- a. Single rod electrode - 25ohms.
- b. Multiple rod electrodes - 25ohms.

### 3.9.4 Medium-Voltage Cable Test

After installation and before the operating test or connection to an existing system, the medium-voltage cable system shall be given a high potential test. Direct-current voltage shall be applied on each phase conductor of the system by connecting conductors as one terminal and connecting grounds or metallic shieldings or sheaths of the cable as the other terminal for each test. Prior to making the test, the cables shall be isolated by opening applicable protective devices and disconnecting equipment. The test shall be conducted with all splices, connectors, and terminations in place. The method, voltage, length of time, and other characteristics of the test for initial installation shall be in accordance with NEMA WC 7 or NEMA WC 8 for the particular type of cable installed, except that 28 kV and 35 kV insulation test voltages shall be in accordance with either AEIC CS5 or AEIC CS6 as applicable, and shall not exceed the recommendations of IEEE Std 404 for cable joints and IEEE Std 48 for cable terminations unless the cable and accessory manufacturers indicate higher voltages are acceptable for testing. Should any cable fail due to a weakness of conductor insulation or due to defects or injuries incidental to the installation or because of improper installation of cable, cable joints, terminations, or other connections, the Contractor shall make necessary repairs or replace cables as directed. Repaired or replaced cables shall be retested.

### 3.9.5 Low-Voltage Cable Test

Low-voltage cable, complete with splices, shall be tested for insulation resistance after the cables are installed, in their final configuration, ready for connection to the equipment, and prior to energization. The test voltage shall be 500 volts dc, applied for one minute between each conductor and ground and between all possible combinations conductors in the same trench, duct, or cable, with all other conductors in the same trench, duct, or conduit. The minimum value of insulation shall be:

$R$  in megohms = (rated voltage in kV + 1) x 1000/(length of cable in feet

Each cable failing this test shall be repaired or replaced. The repaired cable shall be retested until failures have been eliminated.

### 3.9.6 Liquid-Filled Transformer Tests

The following field tests shall be performed on all liquid-filled transformers. Pass-fail criteria shall be in accordance with transformer manufacturer's specifications.

- a. Insulation resistance test phase-to-ground.
- b. Turns ratio test.
- c. Correct phase sequence.
- d. Correct operation of tap changer.

### 3.10 MANUFACTURER'S FIELD SERVICE

#### 3.10.1 Installation Engineer

After delivery of the equipment, the Contractor shall furnish one or more field engineers, regularly employed by the equipment manufacturer to supervise the installation of the equipment, assist in the performance of the onsite tests, initial operation, and instruct personnel as to the operational and maintenance features of the equipment.

### 3.11 ACCEPTANCE

Final acceptance of the facility will not be given until the Contractor has successfully completed all tests and after all defects in installation, material or operation have been corrected.

End Of Section